

Title	Women at the dawn of diamond discovery in Siberia or how two women discovered the Siberian diamond province
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Publication date	2020-07
Original Citation	Kiseeva, E. S. and Yuzmukhametov, R. N. (2020) 'Women at the Dawn of Diamond Discovery in Siberia or how Two Women Discovered the Siberian Diamond Province', in Celebrating 100 Years of Female Fellowship of the Geological Society: Discovering Forgotten Histories, Geological Society, London, Special Publications, 506, pp. SP506-2020-11. doi: 10.1144/SP506-2020-11
Type of publication	Article (peer-reviewed)
Link to publisher's version	https://sp.lyellcollection.org/content/early/2020/07/14/SP506-2020-11 - 10.1144/SP506-2020-11
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Download date	2023-05-04 16:11:41
Item downloaded from	http://hdl.handle.net/10468/10428

Women at the Dawn of Diamond Discovery in Siberia or how Two Women Discovered the Siberian Diamond Province

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Abstract: Exploration for diamonds in the Soviet Union had started in the 1940s, however not until the beginning of 1950s, the government has acknowledged a strong need of locally mined diamonds to support the industry demand. Multiple expeditions were formed aiming to map vast and remote areas in Siberia, Kola peninsula and Far East. In this article, we describe a story of two heroic women, Larisa Popugaeva and Natalia Sarsadskhih, who implemented a new methodology that eventually lead to the discovery in 1954 of the first diamond deposit in the country – a kimberlite pipe “Zarnitsa”. This discovery was made by Larisa Popugaeva, who, in the 1954 field season, conducted the exploration together with a dog Pushok and her technical assistant Fyodor Belikov. Her discovery was stolen by the higher officials from the Amakinskaya expedition, one of the largest diamond exploration organisation in the country. Multiple efforts to restore the justice did not succeed, with

Popugaeva being awarded the title of the “Discoverer” only in 1970, while Sarsadskhih not until 1990. This article provides a detailed description of Larisa’s life until the discovery of Zarnitsa, and a few significant events after.

1. Short notes on Larisa’s biography. Early years

Larisa Popugaeva (nee Grintsevich) was born on the 3rd of September 1923 in Kaluga, a small town 180 km to the South of Moscow (Treivus, 2009; Yuzmukhametov, 1998). Her mother, Olga (nee Tsvetkova), and father Anatoliy Grintsevich (Fig. 1) were closely involved with the communist party. Her father fought for the Red Army during the revolution, and his entire life was a strong Leninist who believed in people’s equality and communist values. Larisa’s nickname was Ninel, for inverted “Lenin”, and that’s how she was called by her family and friends¹.

Larisa’s family travelled a lot during her childhood. In 1924 they moved to Tula, while in 1931, Larisa and her mother moved to Leningrad, where Larisa first went to school. In 1936 the family reunited in Odessa, where Larisa’s father worked in different positions for the party line.

The life of Larisa’s family was typical for any Soviet family of that time, with both parents being great believers in communism, full of enthusiasm to work hard and “build” a new country. However, this positive spirit came to an end in 1938, when a sudden tragedy

¹ Here and below, personal information reported in this article is mostly sourced from interviews of Natalia Popugaeva, Natalia Sarsadskhih and Fyodor Belikov. The interviews were conducted by Rishat Yuzmukhametov.

44 happened. Like many other innocent people during the years of the 'big terror', when the
45 country lost thousands of its citizens, her father was arrested as an 'enemy of the country'
46 and sentenced to death shortly after his arrest (Silaev, 2007). Unfortunately, the
47 bureaucratic machine of that time made all family members of the political 'criminals' carry
48 the burden of the 'country's enemy' for many years ahead. Since their father's arrest, Larisa
49 and her sister Irina were considered almost second-tier people, being stripped of their rights
50 and opportunities, and being allowed only to take certain jobs. It was not until 1959, 21
51 years after his death, that Anatoliy was reinstated and his prosecution was deemed "not
52 supported by evidence".

53 After Anatoliy's arrest, the family returned to Leningrad and settled there. They were very
54 poor and lived in a single bedroom in a dormitory-style block of apartments, sharing kitchen
55 and bathroom facilities with many other families.

56 Larisa's interest in geology started in school. In year 10 (in USSR's system students
57 completed ten years of education after which they could apply to do a university degree)
58 Larisa took a "geology and mineralogy course" and completed it with excellence. She
59 planned to do a degree in geology. However, her plans were impeded by the start of the
60 Second World War (WWII) in June 1941.

61 June 22nd 1941, when Germany attacked the USSR, was a 'canonical' date for every Soviet
62 person, when the life of ordinary people underwent dramatic changes. Most men were
63 summoned to the army, while their families were evacuated from European Russia behind
64 the Urals Mountains where they worked in factories supplying the army. In the first years of
65 the war, the Soviet Army was retreating towards Moscow, while Leningrad was sieged for
66 most of the war. Huge losses made it necessary for women also to volunteer to fight, and
67 Larisa was one of them.

68 Recovering from the events of her life from the start of the war, on the 22nd of June 1941,
69 the family was on a short visit to Moscow, and this is what probably saved them from the
70 gruelling Leningrad siege. A few months later, Larisa's mother and sister were evacuated to
71 Molotov, a small town in the Ural Mountains (now Perm). Larisa joined them in September
72 and being a person who could not be inactive, she immediately applied for a geology degree
73 at the local university (Silaev, 2007). In her diary, on the 23rd of September 1941, Larisa
74 wrote: "... I am very interested in geology and I chose the faculty of geology and soil;
75 however, I had to leave Leningrad urgently...". During the first year of studies, Larisa has also
76 completed a course in nursing and firing a machine gun, and in April 1942, she volunteered
77 in the war. Larisa fought in the 89th Artillery division, whose task was to cover the air space
78 around Moscow (Fig. 2). She received multiple War awards and rank promotions and was
79 demobilised to Leningrad in the rank of sergeant on the 23rd of July 1945, two and a half
80 months after the end of the war. As soon as she returned to Leningrad, Larisa resumed her
81 geological studies in the Leningrad State University (Silaev, 2007).

82 In their memoirs, many colleagues and friends say that Larisa was very different from the
83 other students. Physically, she was short, wore a plat circled around her head and looked
84 feeble; however, she gave an unforgettable impression of a very cheerful and active person,
85 smiling, positive and full of life. Coming back to academia after years spent in the war, she
86 was noticeably older than her peers; she smoked and looked and acted confidently.

87 In 1940th, the mineralogy degree at the Leningrad State University was very strong.

88 Lecturers and professors were some of the best specialists in the country. Professor A.A.

89 Kukharensky introduced to the students the method of panning for heavy concentrate,

90 which was later used by Larisa during diamond exploration. Obtaining the degree was not

91 easy; between September and June students learned theory in specialised topics:

mineralogy, crystallography, geochemistry, petrology and others, while in summer they spent months of field training being enrolled in geological expeditions. Many areas of the USSR, particularly remote, did not have detailed maps, therefore, there was no time to spend on dedicated student field training courses and geology students were sent to help professional expeditions (Kostitsyn, 2016).

On the 28th of May 1950, Larisa has completed her 5-year honours degree as a “geologist” specialised in “geochemistry” (Kostitsyn, 2016). She was ready to start her new life.

2. VSEGEI and Diamonds

Another peculiar procedure in the Soviet Union concerned the distribution of jobs. The jobs were provided to specialists after their graduation. Specialists had very limited options to choose their job location, and many young people had to travel far from their homes to different regions of the country to obtain a job. Larisa was luckily (or given the later events of her life, perhaps, unluckily) offered a mineralogist position at the All-Russia Geological Institute (VSEGEI). VSEGEI was a research institute and was subdivided into multiple expeditions working on mapping, prospecting and exploration in different regions of the country. Larisa was attached to Tungusko-Lenskaya expedition lead by a very experienced field geologist A.A. Krasnov. Among other goals, this expedition’s objective was to conduct diamond exploration and prospecting in a large area in Eastern Siberia (Fig. 3).

2.1. Diamonds in the USSR

113 Before delving into the details of Larisa's work at VSEGEI, we need to take a step back and
114 to elaborate on why having a local supply of diamonds was such a vital necessity for the
115 USSR economy.

116 Diamonds were extensively used in the Russian Empire industry since 19th century. With
117 large industrial growth in the 1920s and 30s, there was also a strong demand for diamonds
118 in the Soviet Union, however, not supported by findings of diamond deposits. Episodic
119 diamond exploration expeditions took place since the early 1920s and targeted areas in the
120 Urals and Eastern Sayan Mountains, but it was only in 1938 that diamonds became a
121 strategic resource prioritised by the government. They were used in drilling, radioelectric
122 industry, tool production, optics and many other industries. Before 1938, USSR imported
123 diamonds for more than two mln rubles a year, and that only covered about 50% of the
124 needs. Before WWII, USSR consumed roughly 23 thousand carats a year, a number similar to
125 the US yearly consumption in 1926 (Yuzmukhametov, 2013).

126 The first long-lasting government expedition for diamond exploration was formed in 1940
127 and it targeted the Ural Mountains. It consisted of geologists from Leningrad and Moscow
128 and during the period between 1940-1946 was the only organisation responsible for
129 diamond exploration in the USSR. It is important to note that at that time diamond
130 exploration was a rather difficult task.

131 The main rock hosting diamonds is kimberlite, erupted as a volcano and forming an
132 explosive crater or a diatreme. Therefore, kimberlite locations are usually referred to as
133 kimberlite pipes. These are some of the deepest originating volcanoes found on Earth. The
134 stability field of diamond (as opposed to its lower-pressure variety graphite) starts at around
135 120-150 km depths, meaning that kimberlite magmas have to travel to the surface from
136 those depths (Yaxley et al., 2019). These are very unusual rocks, bound to stable and

137 geologically rigid regions of the Earth called cratons. The first discovery of diamonds was
138 made in South Africa in Kaapvaal craton, later kimberlite pipes were found in Zimbabwe
139 craton, west African craton and other locations. Up to date, kimberlites are found in most
140 cratons on Earth, including Antarctica (Yaxley et al., 2013). There are several cratons on the
141 territory of the former Soviet Union, with the largest one being the Siberian Craton.
142 Kimberlites were first found in South Africa at the end of the 19th century, kimberlite
143 exploration tools were slowly being developed (Williams, 1902), however, none of the
144 methods were familiar to the Soviet geologists. Furthermore, the political tension between
145 the USSR and the Western block did not permit any communication or collaboration with
146 the geologist abroad. This resulted in a complete lack of any knowledge of how and where
147 to conduct a diamond search. Additionally, there was also a strong lack of knowledge about
148 diamond formation and relation to any rocks.

149 The process of diamond discovery in the USSR is significantly more complicated than for any
150 other mineral resources. As stated above, the entire exploration was purely based on the
151 local experience that was not enough for creating a comprehensive methodology.

152 Some astonishing details about that time could be found in the memoirs of a famous Soviet
153 and later Russian geologist Viktor Masaitis (2004), who worked in the diamond field and
154 lived in Leningrad (Saint Petersburg) until his death in 2019²: *“Newly arrived exploration*
155 *geologists did not receive any instructions that considering the experience from South Africa,*
156 *could have significantly helped their work. They did not have any rock samples. If most other*
157 *ores could be taken into their hands and studied mineralogically and petrographically, or*
158 *could be found in multiple geological and mineralogical museums, the situation with*

² Here in below, in relation to the quoted text. The text was translated in the closest possible way, however, in some instances may not be an exact translation in order to preserve the alleged meaning in Russian.

159 *kimberlites was completely different. The vast majority of field geologists never saw*
160 *diamonds, let alone kimberlites. (...)*
161 *One should not forget that search for diamonds was a “secret” job, and should have been*
162 *kept concealed from “enemy”. This aura of secrecy significantly hurdled the exchange of any*
163 *information, especially at that stage when there was initially very little information about*
164 *the distribution and formation of diamonds. Most of geological and topographical maps and*
165 *books on diamonds and their mining were “classified”. Every room where geologists who*
166 *were allowed to use this information were admitted, had a special person, usually very*
167 *poorly educated, who vigilantly checked everything around them and reported to the*
168 *government officials. The word “kimberlite”, obviously, nobody said aloud, let alone the*
169 *word “diamond”.*

170 Over the following five years, the political situation was not getting better. If during WWII
171 Great Britain, in the form of military aid, sold to the USSR approximately 2800 carats of
172 technical diamonds (charging 2 carats per 1 pound sterling), with the beginning of the “cold
173 war” this aid was not any longer available (Yuzmukhametov, 2013). The only remaining way
174 of obtaining diamonds was to pay the market price, which was too financially gruelling for
175 the country devastated by WWII. As a result, in 1946 the former head of the Urals diamond
176 expedition M.F. Shestopalov wrote a letter to Stalin, outlining three key goals for the
177 diamond industry:

- 178 1) In short terms to seize import of diamonds into the USSR
179 2) Create a Diamond Trust and expand exploration to multiple areas within the USSR
180 3) To target every area of the country where diamonds were previously found.

181 Less than a month later, Stalin invited Shestopalov to the Kremlin and approved his proposal
182 (Yuzmukhametov, 2013). Diamond exploration works were expanded to the following

regions of the country: Yenisey River, East Sayan mountains, the Angara and Podkamennaya Tunguska Rivers and Kola Peninsula. Additionally, some work was planned in the Far East, in the Eastern and Western Siberia, in Kazakhstan, North Caucasus and Tajikistan. By the beginning of 1950s alluvial diamonds were found within a large area in Siberia between rivers Yenisey and Lena, and a range of Moscow and Leningrad research institutes were given a task to expand the diamond exploration in that region. This coincided with the new embargo that in 1950 the USA set on diamond trading with all countries of the Socialist block, leaving USSR nothing else but pushing the exploration forward at the fastest rate.

2.2. Larisa Popugaeva meets Natalia Sarsadskih

In February 1950, the Central expedition based in VSEGEI, Leningrad, established a branch aimed to create a “heavy fraction map of Siberian platform”. Natalia Sarsadskih (Fig. 4), an experienced geologist was appointed as the head of this branch (Melua, 2003; Yuzmukhametov, 1998). Natalia’s task was to investigate the heavy fraction of the basement rocks in the Siberian platform and to link it to the alluvial minerals. Additionally, the goal was to locate mineral-indicators of diamonds in the potential alluvial diamond deposits. The scale of the map was supposed to be 1:500000, which was an enormous task for an area of almost 1500 km in length (Sarsadskih, 1997; Sarsadskih, 2004).

An interesting observation concerning the Soviet women, Natalia was married to a famous geologist Alexander Kucharenko, yet, kept her maiden name, which was, perhaps, unusual, but not rare.

206 In the summer of the same year, Larisa was working in the Lower Tunguska region in
207 Krasnov's expedition. This is how she first met Natalia Sarsadskih, who spent some of the
208 time in the same expedition.

209 In April 1951 Larisa changed her job and also started working in the VSEGEI branch of the
210 Central expedition. The main reason for this move is still unknown, however, it was likely
211 due to the pressure created by her status of a daughter of the "country's enemy", that
212 disabled her to work on certain jobs, in particular, those that had "classified" information.
213 This year she travelled to the Polar Urals on a task unrelated to diamond exploration
214 (Kostitsyn, 2016).

215 In spring 1952, Larisa and her future husband Viktor Popugaev moved in together, and in
216 September Larisa gave birth to daughter Natalia. Larisa called her after her dear friend
217 Natalia Sarsadskih. On the same day, on the 27th of September 1952 Larisa and Viktor got
218 officially married and Larisa changed her family name from Grintsevich to Popugaeva. This
219 marriage was not the most successful as her husband used to drink excessively. Later, he
220 also changed his career to academia and worked as a lecturer in an engineering institute of
221 Leningrad. Viktor outlived Larisa by 17 years.

222 From memoirs of Larisa's daughter Natalia: *"The entire history of the discovery of Zarnitsa I*
223 *learned only after my mother's death. She used to repeat the same phrase: "don't be afraid*
224 *of your enemies, in the worst case, they can kill you. Don't be afraid of your friends – in the*
225 *worst case they can betray you. Be afraid of those indifferent. They do not kill and do not*
226 *betray, but from their quiet consent there happen betrayals and murders". For me, the main*
227 *mother's qualities were emotionality and honesty. She really loved children and animals.*
228 *During my mother's short live she helped a lot of people. I was always amazed by how fully*

229 *she dedicated herself to work. Nothing could stop her – neither her husband, not her*
230 *daughter...”*

231

232 *2.2. 1953 field season and Larisa’s first diamond-exploration expedition*

233

234 In spring 1953, Natalia Sarsadskih received a letter from Larisa requesting to join her on the
235 field trip to Yakutia. Natalia has agreed to include Larisa into her expedition and since the 1st
236 of April 1954, the two women started working together. For the following year and a half,
237 Larisa and Natalia became the closest friends going through the tough field work conditions
238 in Siberia together.

239 As mentioned earlier, Natalia addressed diamond exploration from the mineralogical side;
240 her main goal was to find a mineralogical exploration tool, in particular, mineral-indicators
241 of diamondiferous rocks. Thorough study of previous findings made her believe that
242 previous conclusions about mineral indicators were inaccurate, therefore, the entire 1953
243 field season was aimed at a new search. For this purpose she chose upper Markha river, not
244 a random location, given that in the lower Markha river the diamonds have already been
245 found.

246

247 Getting to the location was not a trivial task. The first leg of a journey was to fly to Yakutsk,
248 a major city and a capital of Yakutia (Sakha Republic) (Fig. 4), then a local flight to a small
249 town of Olenek, located on Olenek river (Fig. 4), and from there 250 km of a journey
250 through taiga, heading south towards river Daldyn, a tributary of Markha, using the local
251 deers to carry the food and supplies. The actual work was supposed to be carried along the

252 two rivers – Daldyn and Markha (Fig. 4), collecting the river sediment and panning it for the
253 heavy fraction.

254 The expedition started in late June, when both Larisa and Natalia flew to Olenek, and they
255 only reached Daldyn by mid-August.

256 In 2007 Larisa's daughter Natalia found her mother's diary from this trip and below, we will
257 list some of the entries. The entries between July and mid-August were made during a 250
258 km hike between Olenek and river Daldyn.

259 *26.07.53 – we sleep in tents, laying on the ground everything we can because only 10 cm*
260 *below the moss is permafrost or permanent ice. It is very cold at night, while during the day*
261 *it is unbearably hot. Along the route, we see the same limestones, there are a lot of trap*
262 *fragments³. Our caravan consists of 43 deers, out of these, five sled deers called "uchugs"*
263 *are assigned to our expedition. I have a lucky one: ugly, with small horns, but a very frisky*
264 *one. At first, I was not getting along with it, but now I have got comfortable, and feet are not*
265 *getting too tired. It is the first time in 7 years of my work that I have a deer to ride during a*
266 *field trip*

267 In her memoirs, Natalia Sarsadskhih wrote:

268 *"Larisa and I at times allowed ourselves to ride deers. However, this "rest" was very*
269 *doubtful; we were not told how to ride a deer. Once, when stopped at an outcrop, I*
270 *unleashed a deer and wanted to climb on it from a stump. That didn't go well, it kicked me*
271 *from the saddle and ran after the rest of the deer herd. I suddenly felt a sharp pain in my*
272 *lower back, and barely crawled back to the base. That frightened me a lot because I was not*
273 *alone, together with me travelled my not yet born daughter. I was afraid for her".*

³ Larisa refers to the trap basalts that cover the area

274

275 Natalia's statement shows how strong these women were and how much hardship they had
276 to go through doing their job. Pregnancy was not an excuse to take a 3-month long trip to
277 gruelling conditions in Siberia: to be bitten by midges and mosquitos, to starve, to pan
278 buckets of sediment in a freezing cold water, to set up tents in snow not having proper
279 clothes and boots.

280 The 250 km journey between Olenek and Daldyn river was exhausting. Continuing Larisa's
281 diary:

282 *1.08.53. We are trying to get close to river Siligir⁴, hoping for better hunt and fishing,*
283 *because now we do not have many supplies left and the food is vanishing very fast.*

284 *11.08.53. The time flies so fast, and we are still far away from work. The deers are lost.*
285 *Hunters search for their deers, while the latter are running in a search for mushrooms. Today*
286 *we ate three ducks. But in general – it's a dense and lifeless taiga. I feel fearful and pity.*

287 *15.08.53 We haven't moved from this spot for three days. Terrible, and everything is futile.*
288 *We are missing 19 deers. We are consuming the groceries, while the work isn't being done. I*
289 *really want to go home. We still have 60 km to Daldyn. Yesterday we searched for deers,*
290 *walked about 10 km and found only three of them. It is cold, and it rains all the time.*

291 *26.08.53. We finally got to Daldyn. It's beautiful here. Taiga is dressing into its autumn*
292 *decor. The grass is dark-red. We have panned some sediment.*

293 *30.08.53. In the morning I planned to go into a 4-day long route without the sacks, only with*
294 *a tent. Grrrrr.. I can only imagine.. The weather is terrible. It does not stop snowing.*

⁴ Siligir is a tributary of Olenek River, see Figure 4.

295 05.09.53. *Nothing has changed; we sifted about 100 buckets of sediment. It is cold, but it's*
296 *tolerable.*

297 14.09.53. *I am in a tent. The boots are torn in pieces. Outside of the tent the snow is up to*
298 *the knee. It looks nice and soft, but if you step into it, it's grrrrr, cold. Today we'll have to*
299 *walk another 20-25 km through the snow, but this is not the worst. There's barely any food*
300 *left. It's been three days already that we didn't have any bread. We're using flower to make*
301 *soup. But it's all right, we'll cope! I really hope that our today's hunt will be successful.*

302 20.09.53. *It's frosty, the river has frozen near the banks up to 15 meters, and we have*
303 *another 900 km to raft. There is no more food left, only a few cans of preserves and some*
304 *salt. In 8 days my daughter is turning one – such a big girl, so pity that I am not at home.*
305 *How is my family going to celebrate this day?*

306 After reaching Daldyn, Larisa and Natalia split into two groups; Natalia went on a route
307 along river Sytykan, that flows parallel to Daldyn, while Larisa and her assistant Fyodor
308 Belikov were rafting along Daldyn.

309 While working in Daldyn river, Larisa and Fyodor panned about three cubic meters of sand.
310 This is 300 10-liter buckets. Even if the sand is clean and does not contain any mud, this job
311 would take about 150 hours of work (Kostitsyn, 2016).

312 Having regrouped, the geologists stopped in a village called Shelogontsy, 130 km to the
313 south from Daldyn's estuary. By that time, the village was abandoned and hosted only a
314 geological base. Later in 1975 during an interview, Larisa confessed that they arrived at
315 Shelogontsy so hungry that she stole a loaf of bread from one of the local geologists.

316 Together with Fyodor they immediately ate it. The geologists at Shelogontsy had
317 photoluminescence equipment. Larisa investigated the heavy fraction sifted at Daldyn river
318 and found a small diamond crystal. They were delighted. Natalia remembered that she and

319 Larisa were dancing out of happiness when they discovered this diamond. One of their
320 dreams had come true. They found a diamond!

321 From Shelogontsy, they flew to Nuyrba, a town that hosted the headquarters of the
322 Amakinskaya expedition, the main diamond exploration party in the USSR (Yuzmukhametov,
323 2010). Given a degree of rivalry between the expeditions located in different cities, the
324 relationship between Leningrad and Nuyrba geologists were relatively cold. Therefore, the
325 geologists tended not to share any information about their exploration routes and
326 discoveries. As this field work was led by Natalia, she was very vigilant and experienced,
327 minimising communication with the Amakinskaya group. Next year Larisa will make a
328 mistake of being much more open, and that made her pay a high price.

329 On their way to Leningrad, Natalia and Larisa stopped for a few days in Irkutsk. There Larisa
330 met with Natalia Kind and Ekaterina Elagina – these two women were future discoverers of
331 the second largest diamond mine in the USSR – kimberlite pipe Mir. They become very close
332 friends with whom Larisa kept close contact for the rest of her life.

333 The 1953 field season was over, and it brought one diamond.

334

335 *2.3. 1954 field season. Leading the exploration*

336

337 As stated earlier, one of the main difficulties in the exploration work was the lack of any
338 exploration methods that target diamonds. While in South Africa it has long been known
339 that chromium-rich purple pyrope garnets were the key indicator minerals, in the Soviet
340 Union, this mineral was largely overlooked. This was not entirely due to the lack of evidence
341 or knowledge, but partially due to the fear of taking any responsibility and propose
342 something new, especially based on the experience of western geologists. As an example, in

343 1938, A.P. Burov, who was a leading diamond exploration geologist in the USSR between
344 1937 and 1956 prepared a report in which he stated that *“the most typical minerals that*
345 *accompany diamonds are olivine, ilmenite, chromite, pyrope, phlogopite, perovskite and*
346 *diopside”*. All these minerals are typical for kimberlites and if this report had been
347 published, it would have substantially helped the future exploration. However, Burov
348 decided not to expose it and the report was only found in 1992 in archives. Historians
349 hypothesised that the reason of why this report was never published was that earlier in
350 1937, two experienced diamond exploration geologists who proposed to link parental
351 diamondiferous rocks in the USSR to the similar rocks reported by South Africans, were
352 arrested. Back in those times, it took as little as someone’s minor complaint to be arrested
353 and prosecuted.

354 Coming back to Natalia and Larisa’s expedition, in the heavy fraction they found both
355 ilmenite and pyrope, however pyrope was not a commonly well-known mineral, and
356 although determined as garnet, it only reminded the geologists of the so-called “bohemian
357 garnets”, found in Bohemian massif in Czechoslovakia. The only samples of African
358 kimberlite-derived pyropes were kept in the Department of Mineralogy of the Leningrad
359 State University. These samples derived from Jagersfontein kimberlite pipe and were
360 bought by the Russian empire in 1912. Alexander Kucharenko, Natalia’s husband, had access
361 to those pyropes, however, as a rule in their family, they decided not to bring work home,
362 therefore, Alexander was not familiar with Natalia’s projects. Surprisingly, it was Larisa who
363 addressed Alexander to compare minerals found in Daldyn River with the pyropes from
364 Jagersfontein mine. They were identical.

365

366 Later Natalia Sarsadskhih wrote in her memoirs: “I only learnt about pyropes from
367 Alexander when he came home from work. That evening Larisa visited us. Our second
368 dream came true – we found mineral-indicators of diamonds, and consequently, now we
369 have an exact area where to search for kimberlites. We have excellent results! The task for
370 our 1953 is fully accomplished! There is no end to my and Larisa’s joy!”

371

372 This discovery has set the goals for the 1954 expedition. Geologists had to return to the area
373 and pan the heavy fraction along Daldyn River basin. The rationale was the following: the
374 number of minerals, ilmenites and pyropes in the heavy fraction will depend on the
375 proximity to the ore body. Pyropes are more resistant to transportation than ilmenites, and
376 additionally, being red, or purple, they are easier to notice. Therefore, Natalia called this
377 “pyrope mapping”, or a “red guiding thread” which was supposed to lead to the diamond
378 ore body.

379 The “panning of heavy mineral concentrate” revolutionised the diamond exploration in the
380 USSR. Importantly, it was incredibly cheap and mainly required labour.

381 In February 1954, Natalia gave birth to a daughter, Lena, which made it impossible for her to
382 travel to Daldyn. Natalia hoped to ask Larisa to do this work, but Larisa suddenly refused.

383 Later, Natalia wrote that Larisa was very distressed, she apologised for not being able to go,
384 visited Natalia at home and cried. Natalia tried to convince Larisa that they should finish the
385 work that they started, while Larisa was saying that she would not cope alone. It was only
386 later that Natalia found out the two main reasons for her refusal, Larisa applied to do a PhD
387 in Leningrad Mining Institute, but more importantly, she was pregnant with her second
388 child, and she never dared to tell anyone. Therefore, being torn between her life, family and
389 work, she was stressed and upset. Eventually, Larisa’s hardworking and heroic nature took

390 over; she consciously decided to lose the baby and started getting ready for her Siberian trip
391 (Kostitsyn, 2016).

392 Another problem arose from the bureaucracy. The abovementioned head of the Central
393 expedition, Burov, refused to financially cover the trip because the Daldyn location was not
394 in the plan for exploration works in 1954 (Elagina, 2003). Larisa managed to find money only
395 for two members of the expedition – herself and her loyal assistant and a good friend
396 Fyodor Belikov, who did the field work with her during the previous year. But even that
397 money did not come from one source. Larisa had to be partially funded by the rival
398 Amakinskaya expedition, while the head of Tungusko-Lenskaya expedition, Ivan Krasnov,
399 covered Fyodor's subsistence and travel (Sarsadskhih, 1990; Sarsadskhih, 1997; Sarsadskhih,
400 2004). These details to the story are important because it was this connection with the
401 Amakinskaya expedition that later allowed the head geologists of this organisation to assign
402 Larisa's discovery to themselves.

403 Larisa left for the field at the end of June 1954, accompanied by Fyodor and her husband,
404 who was worried about Larisa and preferred to travel with her (Kostitsyn, 2016). However,
405 according to Larisa, her husband was more of a burden, therefore, she asked him not to
406 continue the trip and to return home. In Nyurba geologists collected all the necessary
407 "equipment" for the trip: bucket, shovel, pickaxe, a tray to pan the heavy fraction and a
408 magnifying glass. They also picked a homeless dog Pushok, whom Larisa managed to take on
409 the plane to Daldyn, making this dog a witness to the first kimberlite discovery in Siberia (fig
410 5). The field work lasted until September 1954 (Fig. 6a)

411 While staying in Nyurba and waiting for the plane to Daldyn, Larisa did not make a secret of
412 the previous season of work. She told her peer geologists from Amakinskaya expedition
413 about Daldyn, diamond and pyropes (Treivus, 2014). Many of her friends called her naïve,

414 however, is it really naïve to trust your colleagues and to share your achievements with the
415 others?

416 Already in the field, Larisa wrote a short poem that tells about women-geologists in the
417 field:

418 I live in a tent as a man,

419 I wear men's boots

420 Lumps of mud get stuck to them

421 Creating circles in water

422

423 I touch a quiet rock

424 When taiga is humming in rain

425 And geologists say that this rock

426 Is the same rock as in my chest

427

428 As a pine in the wind,

429 I succumb to tension

430 It is difficult for me

431 To be such as a man

432

433 I would really want

434 Even for a moment

435 To fall into your arms

436 And to be weak again.

437

438 This season's field work was not the same as in the previous one. From time to time, Larisa
439 and Fyodor had unexpected visitors from the Amakinskaya expedition (Fig. 6b) (Treivus,
440 2014). Higher authorities explained that by the fact that Larisa needs help, however, nobody
441 doubted that geologists in Nyurba realised how close Larisa was to discovery. The head of
442 Amakinskaya expedition A. Bondarenko could not allow a "stranger" from Leningrad to take
443 the glory of discovery, therefore, he sent his people to check on her and to follow her routes
444 along the river.

445 Once, when after another long route Larisa saw four more tents in her camp; herself and
446 Fyodor collected their tents and went a different way, she could not tolerate an increasing
447 number of guests.

448 This field season was somewhat better than the previous one in respect to the supplies. In
449 her letter to mother, Larisa wrote that the entire summer they had meat, because Fyodor
450 hunted two deers (Treivus, 2014).

451 Larisa and Fyodor crossed Daldyn and went towards a creek called Dyakha (Fig. 7). It should
452 be noted that in her work Larisa did not have any mercy of herself. She went into the taiga
453 without sleeping bags, far from their tents, frequently spent nights just sitting under the sky.
454 Her hands were scratched and knees were full of lashes because she searched for pyropes
455 sitting on her knees. Along Dyakha Larisa and Fyodor found a lot of ilmenites. Larisa made a
456 correct conclusion that the parental rocks should be somewhere in the watershed of these
457 two rivers – Daldyn and Dyakha.

458 From Fyodor Belikov's memoirs: *"We climbed to the top of the hill. Larisa immediately found*
459 *an ilmenite there. Ah, what was next. We started to search the moss, even forgot to smoke.*
460 *There were a lot of ilmenites there, and Larisa said: "What a mysterious place! Let's go down*
461 *towards the river, rest, and return here in the morning". The next day we spent on this hill,*

462 while during the following day we went towards a small valley with short and rare larches.
463 By lunchtime, it started raining. We had a piece of tarpaulin and used it as a cover. To warm
464 up, I decided to lit a fire and heat up a large stone, so that it would act as an oven. I lit a fire
465 and invited Nelya⁵ to stay next to this stone below the tarpaulin. She sat down and suddenly
466 jumped, picking up a magnifying glass: "Look, Fedyunya!⁶ Blue mud, and full in pyropes".
467 This was the first kimberlite pipe found in Siberia. Larisa and Fyodor took samples and
468 erected a post, under the post they left a note stating that here they found a very rich
469 pyrope-ilmenite and possibly a diamond deposit.
470 The pipe was called by a geologist M. Gnevushev – "Zarnitsa", which means a distant,
471 sudden and ephemeral flash in the sky, a gleam of a distant thunderstorm. Larisa Popugaeva
472 herself was as a "zarnitsa", a "gleam" in the diamond history of the USSR. Larisa wanted to
473 call the pipe "pipe of Shestopalov" commemorating the name of the chief of the Central
474 expedition, who died in 1954.

475 3. *"Had I known what would happen, I would have never wanted to*
476 *discover Zarnitsa".*

477 It was the end of 1954 and time to return to Leningrad. Larisa and Fyodor took 60 kg of the
478 heavy mineral concentrate, carrying them in rucksacks, and specimen of the found rock.
479 Larisa could not contain her feelings: *"Flowers and champagne are waiting for me!"*.
480 On their way back they stopped in a little town Yaralin, from where the plane was supposed
481 to take them to Nuyrba. According to local geologists, Larisa was impatient to check that the

⁵ Here and below, Nelya is a shortened diminutive version of Ninel, Larisa's nickname given to her by her father. In fact, Nelya is a version of a different Russian name Nelly, yet, Larisa seemed to have adopted this short name among her friends and colleagues.

⁶ Fedyunya is a diminutive form of Fyodor, usually used for children or very close friends.

482 heavy mineral concentrate collected near Dyakha contained diamonds. Therefore, she went
483 directly to Yaralin, where the plane could collect her faster than in Shelogontsi, the place
484 where she and Natalia stopped in 1953 (Kostitsyn, 2016).

485 In Yaralin they found one diamond in the heavy concentrate, which confirmed that the
486 found ilmenite-pyrope deposit was diamond-bearing. Yaralin was also considered fatal for
487 the future of Larisa and her work. Nobody knows what happened and what plans Larisa had,
488 but knowing that she discovered a diamond-bearing location, most likely a diamond deposit,
489 she did not contact Natalia and did not send her a rock sample. In fact, Larisa spent more
490 than two months in the taiga and never sent a single message to Natalia, who was
491 desperately waiting for the news.

492 Later Natalia wrote that it was from another geologist who incidentally was in Leningrad
493 that she found out about Larisa's discovery. Natalia was shocked and devastated by the fact
494 that her best friend had never got in touch with her and the only hand specimen she had,
495 was transported to Leningrad by a distant person. *"How could Larisa share this specimen*
496 *with him and not with me?"* – wrote Natalia.

497 By the time Larisa arrived at headquarters of Amakinskaya expedition Nyurba, the decision
498 had already been made. The superiors decided to force Larisa to quit her job for the Central
499 expedition in Leningrad and to sign up as an employee of the Amakinskaya expedition. That
500 would allow them to claim the discovery and to keep Natalia and Leningrad's expedition
501 away.

502 The events happened in Nyurba during the following few months, although constrained
503 quite well, do not depict the exact detail of the situation. It is well-known that Larisa was
504 threatened, blackmailed and not allowed to fly back to Leningrad. She could only travel back

505 to her family after she signed all the papers assigning the discovery to the Amakinskaya
506 expedition.
507 A fellow female geologist from this expedition Natalia Kind wrote: *"In Nyurba they drove*
508 *Nelya to hysteria"*. A large report issued immediately after the field work and sent to the top
509 officials stated that Amakinskaya expedition had discovered two diamondiferous fields in
510 the region. In the meanwhile in Lenindgrad, Natalia Sarsadskih was not aware of the events
511 occurring in Nuyrba. Only later in October she received a telegram congratulating her on the
512 great achievements of her group. Larisa never wrote to her. Natalia was absolutely sure that
513 it was due to Larisa's vanity, pride and desire to be the only discoverer, she did not want to
514 communicate with Natalia any more.

515 From memoirs of Ekaterina Elagina: *"Being a difficult, stressful condition, Popugaeva was so*
516 *frightened that she was afraid to talk to anyone. (...) The officials lost their patience and*
517 *promised her that she would never see her daughter or husband again, and will share her*
518 *father's destiny"* (Elagina, 1999; Elagina, 2003).

519 Ultimately, Larisa gave up and signed the documents transferring her to Amakinskaya
520 expedition. This gave the priority of the first kimberlite pipe discovery to an organisation
521 that did not have any rights to claim it. Moreover, the geologists from Amakinskaya
522 expedition have removed the post set by Larisa and Fyodor and announced that the location
523 was incorrect, moving it 200-300m to the side.

524 4. Burden of being the first

525 Sarsadskih never forgave Larisa for changing affiliation. This event haunted her for her
526 entire life, poisoning her relationship with her colleagues and making her change the job
527 and leave the diamond exploration field.

528 Many people later stated that although Larisa behaved disrespectfully, she was
529 manipulated, forced and ultimately threatened. This was not a willing choice and she
530 certainly was not driven by a desire to have all the glory to herself. In 1954 Larisa was a 31-
531 year old young professional who conducted her first independent field work. Defending
532 herself in front of much older, more experienced and forceful superiors was not easy.
533 During the following years, Larisa tried to reconcile with Natalia and to reestablish the
534 justice. She talked to people, wrote letters to the higher officials and tried to publicise
535 Natalia's achievement.

536 To slightly smoothen the conflict, in 1955 Natalia and Larisa received an official gratitude
537 and award of one-month payment for conducting exploration work in 1953-1954 seasons.
538 Fyodor Belikov also received a gratitude and two-months' salary (because his salary was
539 substantially lower than the lead geologists of the trip).

540 In April 1957, six leading male geologists of Amakinskaya expedition received one of the
541 most prestigious Soviet award – Lenin Prize. However, both Larisa (although acknowledged
542 as a discoverer), and Natalia were left aside (Yuzmukhametov, 1998; Yuzmukhametov,
543 2004).

544 In the summer of 1955, using Larisa's and Natalia's panning method and data, three other
545 kimberlite pipes were discovered in the region: Udachnaya, Mir and Sytykanskaya. Both
546 women were never acknowledged of these discoveries.

547 Later in 1957 Larisa wrote a letter to Nikita Khrushchev, the leader of the USSR, requesting to
548 investigate the events of 1954. The reply was disappointing, the government committee did
549 not find any law infringements and hence the reason to revert the prize awardees.

550 Yet, during the next round of government awards, Larisa was granted with the Order of
551 Lenin, the highest civilian award by the Soviet Union, and Natalia received The Order of the

552 Great Banner of Labour, an award given for services to the country and society. None of the
553 women were recognised to be the discoverers of diamonds in Siberia.

554 In 1970 Larisa finally received a status of the Discoverer of a mineral deposit. On the 16th of
555 April 1970, she was granted a diploma "For discovery of diamond deposit kimberlite pipe
556 Zarnitsa in Yakutskaya ASSR".

557 Only some 35 years later, in 1990, Sarsadskih received the same status. Also, a large
558 diamond found in Yakutia diamond province was called in honour of Natalia.

559 The price of this discovery ended up being enormous. Larisa and Natalia could not continue
560 in the diamond exploration field and, importantly, lost each other as friends. The bright
561 flashing light of "Zarnitsa" had separated them forever.

562 In 1970s the news of Larisa's discovery and her name were widespread all over the world.

563 Only in 1973 her name was mentioned in more than 100 Soviet and international
564 publications, there were radio and TV programs dedicated to her. Larisa did not like being a
565 celebrity. She rejected a proposal of a Moscow sculptor Vera Isaeva to erect her monument.

566 In her letter to Isaeva, Larisa wrote: *"Yes, I happened together with Fyodor Belikov to
567 discover the first diamond deposit in the USSR. (...) However, the subsequent events, linked
568 to this discovery, brought into my life such a huge amount of dirt, careerism, lies and
569 distorted facts that I cannot speak about this topic without bitterness and deep insult. Don't
570 misunderstand me, for God's sake, Vera Vasilyevna. You will find many objects, who would
571 like to capture their faces and bodies. Bless them. They, perhaps, should be carolled and
572 sculpted. But this is not for me"*.

573 In VSEGEI Larisa was treated as a traitor, and eventually was compelled to quit that job. In
574 1960 Larisa started her work in the Central Research Laboratory of Gemstones and
575 Semiprecious stones. She became the head of the group that consisted only of two people,

576 including herself. She turned 37 that year, and her life was not easy. Her family included her
577 elderly mum, young sister, husband and an 8-year old daughter. All of them lived in two
578 rooms in a shared communal flat that overall had six rooms. At around that time, Larisa ran
579 into a friend, who later described that meeting: *“Larisa was dressed very poorly, one could*
580 *notice that her life was difficult”*.

581 In 1970 Larisa had finally completed her PhD degree, started in 1950s. Her thesis was
582 dedicated to diamonds and diamond exploration in Yakutia. She was not the only one
583 whose work on diamond exploration in Siberia was not rewarded, and not the only one who
584 had to stop working in this field. Larisa had two closest female friends, both from the
585 “diamond exploration times” in Siberia – Natalia Kind and Ekaterina Elagina. Both lived in
586 Moscow and Larisa frequently visited them.

587 Stressful events and difficult life did not go unnoticed. Larisa developed hypertension. In
588 1971 she was first admitted to hospital and stayed there for four months. Her friends
589 noticed that after that event she could not work as hard as usual.

590 In 1974 Larisa’s family was offered a 3-bedroom flat – a luxury for those times, perhaps,
591 triggered by her award.

592 Later in 1974, she was admitted to the hospital again, with the diagnosis of aortic valve
593 sclerosis. She was suffering from headaches for a long time, as well as had severe pain in her
594 neck, thinking that was a consequence of carrying very heavy backpacks in fieldtrips.
595 Doctors forbade her to smoke that she never adhered to.

596 Larisa’s last visit to Moscow was in September 1977, two weeks after her 54th birthday. She
597 had a work-related trip, but as usual, she stayed at her friend Natalia Kind’s flat. Her
598 husband and daughter waited for her on the platform when she returned to Leningrad by
599 train. She went straight to work, and on her way home from work decided to buy a few

groceries. She never got home. Larisa died instantly on the street from aortic aneurysm. She was buried in Leningrad (Fig. 8).

Natalia Sarsadskikh lived in Leningrad (later Saint-Petersburg) for the rest of her life and died in 2013 aged 97.

Fyodor Belikov never travelled to Yakutia again until 1985, when he was invited to star in a documentary film – “Yuakutian Diamonds”. He lived his entire life with his wife in a shared communal flat on Vasilyevskiy island in Leningrad. His “house mate” was an aggressive alcoholic, while Fyodor worked as a driver of a waste disposal truck. The last “celebration” in Fyodor’s life occurred in summer 1994, when he was invited to celebrate 40 years since the discovery of Zarnitsa. He died in the beginning of 1995.

5. Legacy and life after life

The story of Larisa’s life and diamond discovery was largely publicised. There were multiple authors, both geologists and historians working on the topic, recovering letters and notes from archives. A few films and both fiction and documentary were released in the last 20 years.

Exploration for diamonds in the fields is still continuing and multiple kimberlite pipes were found in the area by multiple expeditions and parties since Zarnitsa discovery (Yuzmukhametov, 2006; Yuzmukhametov, 2010).

The first monument to Larisa was erected at the beginning of the 1990s in the town Mirny, built around the kimberlite pipe Mir.

In spring 2006 at VSEGEI that exists until now, was a large celebration of Natalia Sarsadskikh 90th birthday. Natalia raised her glass and drank to Nelya Grintsevich, the name she used to call Larisa.

623 In 2007 a school in a small town of Udachny in Yakutia was named in honour of Larisa.
624 In 2011 in the museum of the state Saint-Petersburg university was created a fund of Larisa
625 Popugaeva – the most famous graduate of this university during the last 100 years.

626 Acknowledgements and brief notes from authors

627 This article is a combined work by a geologist, whose scientific interests are closely related
628 to diamonds and kimberlites, and a historian, who published more than 30 books and
629 articles in Russian on diamond discovery in Siberia. Despite being well-publicised in the
630 Russian literature, to authors' knowledge there are no articles dedicated to the discovery of
631 Siberian kimberlite field in English. One of the goals of this study is to uncover this story to
632 English-speaking readers. Another goal is to commemorate and acknowledge a great input
633 of women into such a difficult profession as geology in Soviet Union.

634 The story of “Zarnitsa” has already been told by many authors. There are excellent books by
635 Kostitsin, Treibus, Masaitis, Sarsadskhih, Elagina, Silaev and others. The authors apologise if
636 any of the publications are missed from the reference list.

637 The authors are grateful to Bettie Higgs and Cynthia Burek for discussions and editorial
638 handling. ESK thanks Oliver Richards for help with maps.

639

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683 Figure captions

684 Fig. 1. Olga Grintsevich (a) and Anatoliy Popugaev (b), Larisa's parents.
 685 Fig. 2. Larisa Grintsevich (a) after graduating from school, June, 1941 (from Kostitsyn, 2016).
 686 (b) In the army, December 1942 (from personal archives of Natalia Popugaeva)
 687 Fig. 3. Region of Tungusko-Lenskaya expedition mapping area.
 688 Fig. 4. (a) Natalia Sarsadskhih, 1953 (from Kostitsyn, 2016). (b) Natalia Sarsadskhih (right)
 689 and Larisa Popugaeva (left) with geologists from Yakuatian meteorolical station om

690 Shelogontsy, 1953. At the front – Larisa's favourite dog called Verniy ("fateful" in Russian)
691 (photo from Treivus (2014)).

692 Fig.5. Part of Eastern Siberia with the area where the diamond exploration was conducted
693 (see text for description). With stars are shown some of the largest kimberlite pipes of the
694 area. Kimberlite pipes are shown in stars with Zarnitsa (1) as a red star. 2 – Udachnaya, 3 –
695 Sytykanskaya, 4 – Yubileynaya, 5 – Aikhal, 6 – Druzhba, 7 – Internatsionalnaya, 8 – Mir,

696 Fig.6. 1954 field season. (a) Larisa in the field – September 1954. (b) Larisa, Fyodor and
697 Pushok in the field during the visit of the authorities from Amakinskaya expedition. August
698 1954.

699 Fig.7. A sketch of the main geological routes Popugaeva took in 1954 along the river Daldyn.

700 Adopted from Treivus et al., (2014)

701 Fig. 8. Larisa Popugaeva's grave in Saint Petersburg (from Kostitsyn, 2016).

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